HYDROLOGY

C.

C.1. PRECIPITATION

According to the National Weather Service, the Meramec River basin has a relatively humid continental climate with much variability. Climatic influences originate from the Southwest, which carry warm moist air from the Gulf of Mexico or hot dry air from the desert Southwest. During winter, lack of barriers to the north can bring cold Canadian air, dropping temperatures into the sub-freezing range. In summer, 90 degree Fahrenheit temperatures are common for 55 to 60 days.

The National Climatic Data Center's climatological normals presented graphically are based on monthly total precipitation for each year in the 30-year period 1931-60 (Figure 7) and 1961-90 (Figure 8). The precipitation pattern illustrated in the period 1931-60 mirrors the precipitation pattern from the upper to lower basin in the period 1961-90 (Owenby and Ezell 1992). During 1931-60, normal precipitation was highest in Farmington (42.46 inches) and lowest in St. Louis (35.97 inches). Average basin precipitation in the period of 1931-60 was 39.87 inches and 40.96 inches during the period of 1961-90.

Winter months are dry with most precipitation falling in the spring, early summer, and fall months (Figure 8). From 1931-60, average precipitation was highest in May (4.75 inches) and lowest in January (2.22 inches). The same pattern was exemplified in 1961-90 with 4.38 inches during May and 1.89 inches in January.

C.2. USGS GAGING STATIONS

Meramec River basin US Geological Survey (USGS) water discharge gage stations are at Steelville, Sullivan, and Eureka (Appendix B, Figure 1-B to 8-B). These stations collect daily water discharge data, and also house National Weather Service gage-height meters. The following is a list of the location and period of record of the gage stations:

1) Gage station 07013000 in Steelville (Lat. 37 59'58", long. 91 12' 16" in NE1/4, S21, T38N, R4W, Crawford County) has recorded daily water discharge from October 1922 to the current year.

2) The Sullivan gage station, 07014500, is found on the right streambank of Sappington Bridge at river mile (RM) 117 (Lat. 38 09'30", long. 91 06'30" in SE1/4, NE1/4, S35, T40N, R2W, Crawford County). The Sullivan gage station has a period of record of September 1921 to September 1933, and October 1943 to present.

3) The Eureka gage station, 07019000, is found on the right bank, 44 feet upstream from a bridge on the north roadway of I-44 (Lat. 38 30'20", long. 90 35'30", in SE1/4, S32, T44N, R4E). This gage has a longer period of record, August 1903 to July 1906, and October 1921 to the current year.

C.3. PERMANENT AND INTERMITTENT REACHES

Permanent and intermittent stream reaches within the Meramec Basin were tabulated (Table 7) using a combination of information derived from 7.5" topographic maps by Funk (1968) and St. Louis and East Central Fisheries regions (1991). The USGS defines perennial or permanent streams as those having water 12 months of the year during normal precipitation. Permanent streams are identified on USGS maps as solid blue lines. Funk defined permanent streams as those that maintain flow even during periods of drought. The purpose of his study was to determine the miles of water that could provide angling. The geology of this area makes it a candidate for losing and intermittent streams. According to Funk (1968), the Meramec River basin has 201 miles of permanent streams capable of supporting angling.

C.4. AVERAGE ANNUAL DISCHARGE

Flows vary according to precipitation levels. For the 1921-1994 Sullivan gage period of record, representing 1,475 square miles of drainage, the highest 2,313 cfs monthly discharge is in April and the lowest 536 cfs in August (Figure 9). The average annual discharge was 1,227 cubic feet per second (cfs) for the 1921-1994 period of record (USGS 1994). The highest annual mean discharge (AMD) was 3,014 cfs recorded in 1985 and the lowest annual mean discharge, 341 cfs in 1954. Real-time discharge and stage data.

C.5. STREAM/ HYDROLOGIC CHARACTERISTICS

Information found in this section can be used for special projects (e.g., management of high-valued fisheries, instream habitat projects). In addition, this information is useful in understanding wetland functions and will aid in targeting management emphasis.

C.5.1. 7-Day Q2, Q10, Q20 Low Flows, and Slope Index

The 7-day Q2 low flow is the two-year recurrence interval of 7-day low flow. Every two years (Q2) the discharge at the St. James gage station has fallen below 22 cfs for seven days, and every ten years, below 12 cfs for seven days. A large change in flow characteristics occurs near St. James in Phelps County, where flow from Maramec Spring enters the Meramec River. Q2 and Q10 flow for the three gage stations (Steelville, Sullivan, Eureka) on the Meramec River, Huzzah Creek, and Courtois Creek until the period of record 1967 are listed in Table 8. The Q20 for the three gage stations on the main stem Meramec River for period of record 1922-94 was calculated from USGS low flow statistics.

The measure of year-to-year low flow variability is the slope index (SI); it is the ratio of the 2-year to 20-year average low flows (Q2/Q20). Large SI values suggest poor natural water supply and instability from year-to-year (Orsborn 1986). The Q2/Q20 values were determined for the seventh-order Meramec River at an upper-basin site, a mid-basin site, and a lower-basin site. The Steelville gage station, the Sullivan gage at Sappington Bridge, and the Eureka gage have slope indexes of 1.7, 2.1, and 1.9, respectively. These values show well-sustained flows and good basin conditions.

Flows are sustained by adequate precipitation, evaporation, runoff conditions, and ground water supply (sandstone and cavernous carbonate rocks rapidly transmit water from highland areas to deep river valleys where water emerges as springs). Rainfall runoff is important in the Meramec River. Twenty-five percent of rainfall in the basin drains as streamflow and is available for surface water use (UMRCBS Coordinating Committee 1972). The average annual runoff is 10.21, 11.3, 11.43 inches near Steelville, Sullivan, and Eureka, respectively (Vandike 1995). Watershed stability is measured by the influence of watershed constants such as geology, soils (soil water storage), latitude and elevation, topography, and vegetation type. These watershed constants influence the hydrological variables such as stream base flow discharge rates, groundwater levels and daily evaporation. Base flow discharge is the dry-weather discharge of the stream or the average rate of decrease during a period of no precipitation (Skelton 1970).

An estimate of the quantity of flowing water remaining in the stream 30 days after no rain at the Sullivan gage during record 1922-67 is 170 cfs (Table 9). Huzzah Creek near Steelville, in the upper basin, will retain less water after 30 days (22 cfs). Dry-weather flows are considered good within the basin.

C.5.2. Flow Duration Curves and 90:10 Ratio

Figures 10, 11, and 12 show the percentage of time that flow is equaled or exceeded (USGS 1995). Plotted points are midpoints of classes and the percentage of the time that those flows are equaled or exceeded for the given period of record (Osborn 1986). At the Steelville gage on the main stem Meramec River, 267.8 cfs is the median flow or the flow exceeded or equaled 50% of the time (Figure 10). At the Sullivan gage and the Eureka gage, the 50% (median) flow is 600.6 cfs and 1239.8 cfs, respectively (Figure 11, 12). The 90**:**10 ratio (ratio of discharge value exceeded 90% of the time to that exceeded 10 % of the time) for the Steelville gage station, the Sullivan gage station, and the Eureka gage station is 130.23 cfs**:**1,096.2 cfs or 1 to 8.42, 271.0 cfs**:**2412.2 cfs or 1 to 8.90, and 520.7 cfs**:** 6761.8 cfs or 1 to 12.97 respectively. These values suggest, as mentioned above, a lower variability in flow as compared to the Cuivre River basin that has a high ratio of 1 to 218.

C.6. FLOOD FREQUENCY

The volume and rate of discharge can be calculated using the equations from Hauth (1974). Knowing the watershed area and average watershed gradient, the magnitude of a flood event can be calculated. Relationships developed by Hauth (1970), presented in Table 10, were determined by a step-backward multiple regression technique. Hydrologists sometimes call the recurrence interval (RI) the return time measured in years. The magnitude of a flood in cfs is measured for years 2, 5, 10, 25, 50, and 100. Hydrologists derive the recurrence interval from the probability of extreme events. For example, a 100-year (RI) flood of magnitude 68,000 cfs at the Sullivan gage has a 1/100th chance of occurring within any year.

C.7. DAM AND HYDROPOWER INFLUENCES

Although Army Corps of Engineers 404 permits are often required for large impoundments and the MDNR Dam Safety Section regulates non-agricultural, non-federal dams 35 feet or more in height, up-to-date information on the number of small impoundments has been difficult to obtain. The National Wetland Inventory incorporated into this report in the GIS Section now makes this information available.

In a 1966 USDA Meramec River Basin Report, the Army Corps of Engineers advocated constructing the Meramec Park Lake Dam for several reasons: 1) Projected water supply needs for municipal use, 2) anticipated increase in water-oriented recreation use in 1980-2010, 3) the distance of travel from St. Louis, and 4) the economic gain from the resource use.

Several Army Corps of Engineers reservoir projects have been proposed in the basin, but after public review, were defeated. The Meramec Basin project originated in a plan authorized by Congress in 1938 as a means of reducing floods on the Mississippi River (RETA 1973, Vol. I). The Meramec Park Lake project on the main stem Meramec River was one of five reservoirs to be built in the basin. These reservoirs included Meramec, Union, I-38, Irondale, and Pine Ford. An inventory of the Meramec Park Lake project area and the entire river basin was completed by the Ryckman, Edgerley, Tomlinson and Associates, Incorporated (RETA) in 1973. The purpose of the inventory was intended to identify the short and long-term impacts of the proposed project. Physical, biological, cultural elements for the entire basin and the physical, biological, cultural elements for the Meramec Park Lake Study Area were compiled to assess the possible interaction between these elements and also the responses to the proposed alteration (RETA 1973).

The actual dam site was to be within Meramec State Park. The dam would have been made of earth and rockfill (see Land-use Section for more information). The lake would have had a water surface area of 12,600 acres, a total length of 33 miles, and width of 1.75 miles. By 1972, rural opponents, the Citizens Committee to Save the Meramec, encouraged by the newly-formed Ozark Chapter of the Sierra Club, formed to make the public aware of the dam issue (Jackson 1984). In September 1972, Sierra Club filed suit against the US COE, only to lose their case. This court case fueled further opposition. Concern over the loss of wildlife habitat and growing opposition lead to a call for public referendum on the dam issue. Voters residing within the 12 counties of the Meramec River basin and St. Louis decided on August 8, 1978. On that date, 64% of the voters said no to the Meramec Dam (Jackson 1984).

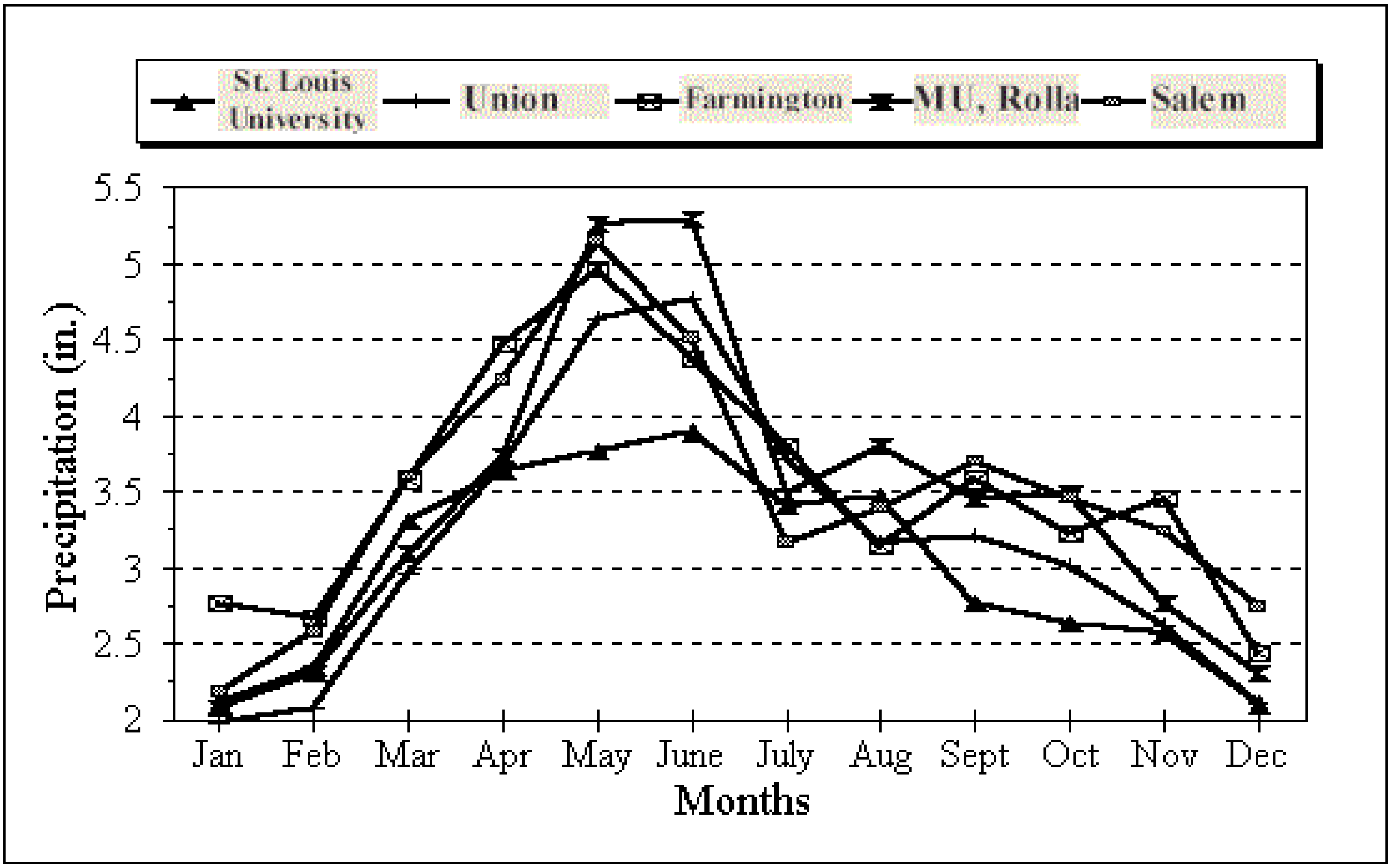


Figure 7. Normal precipitation by National Oceanic and Atmospheric Administration climatological stations within and adjacent to the Meramec Basin--30 year average (1931-1960).

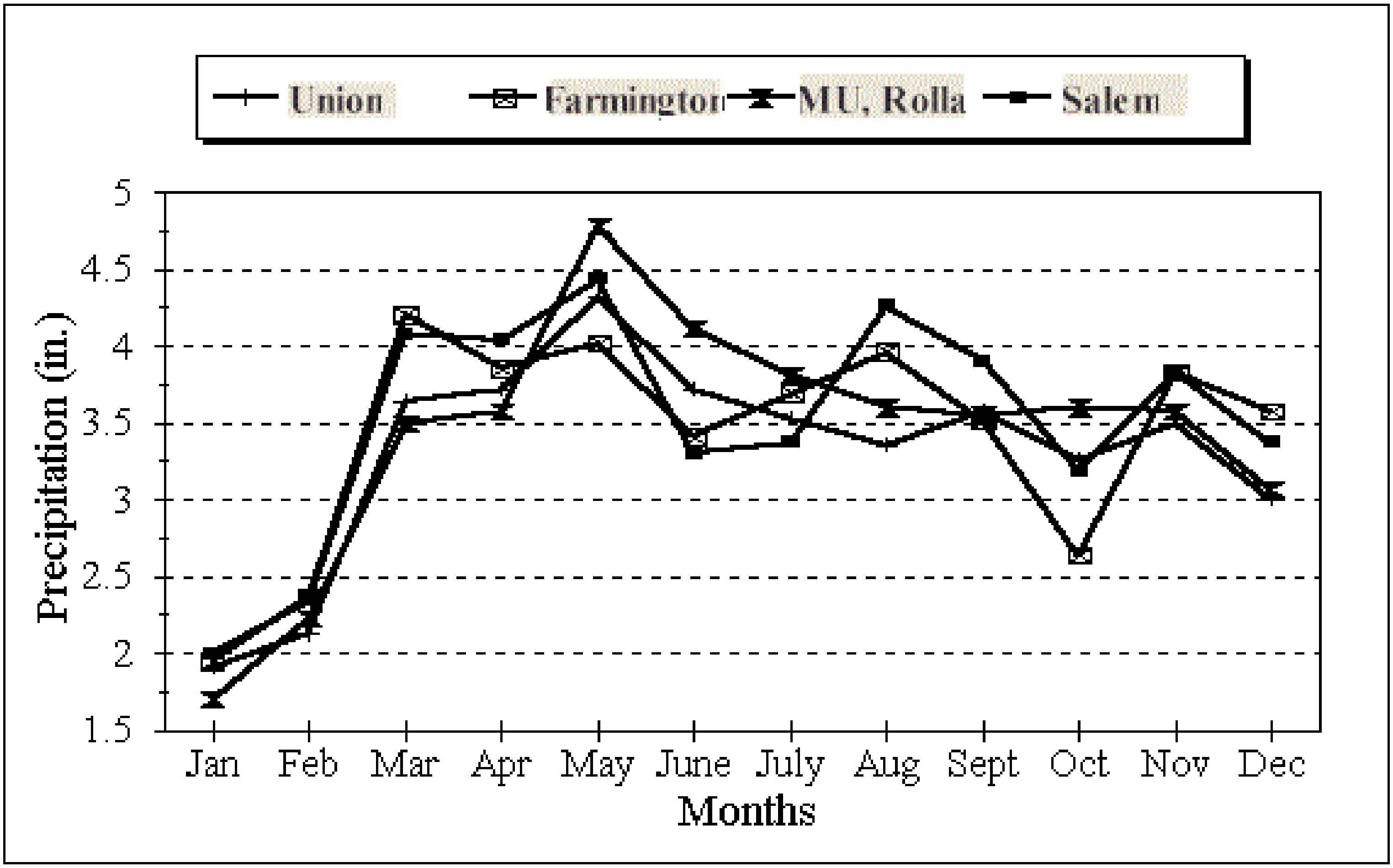
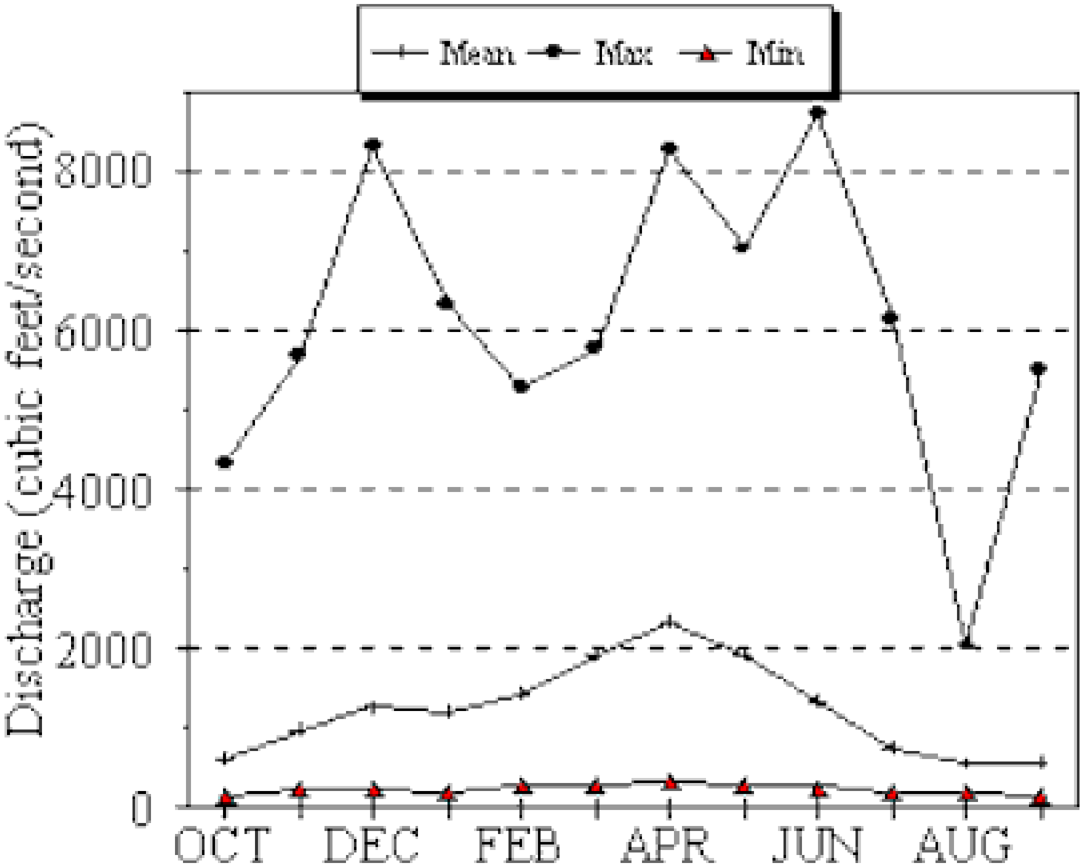


Figure 8. Normal precipitation by National Oceanic an Atmospheric Administration climatological stations within and adjacent to the Meramec Basin--30 year average (1961-1990).

Figure 9. Mean, minimum, maximum annual discharge of the Meramec River at the Sullivan gage station for period of record 1921-1994.



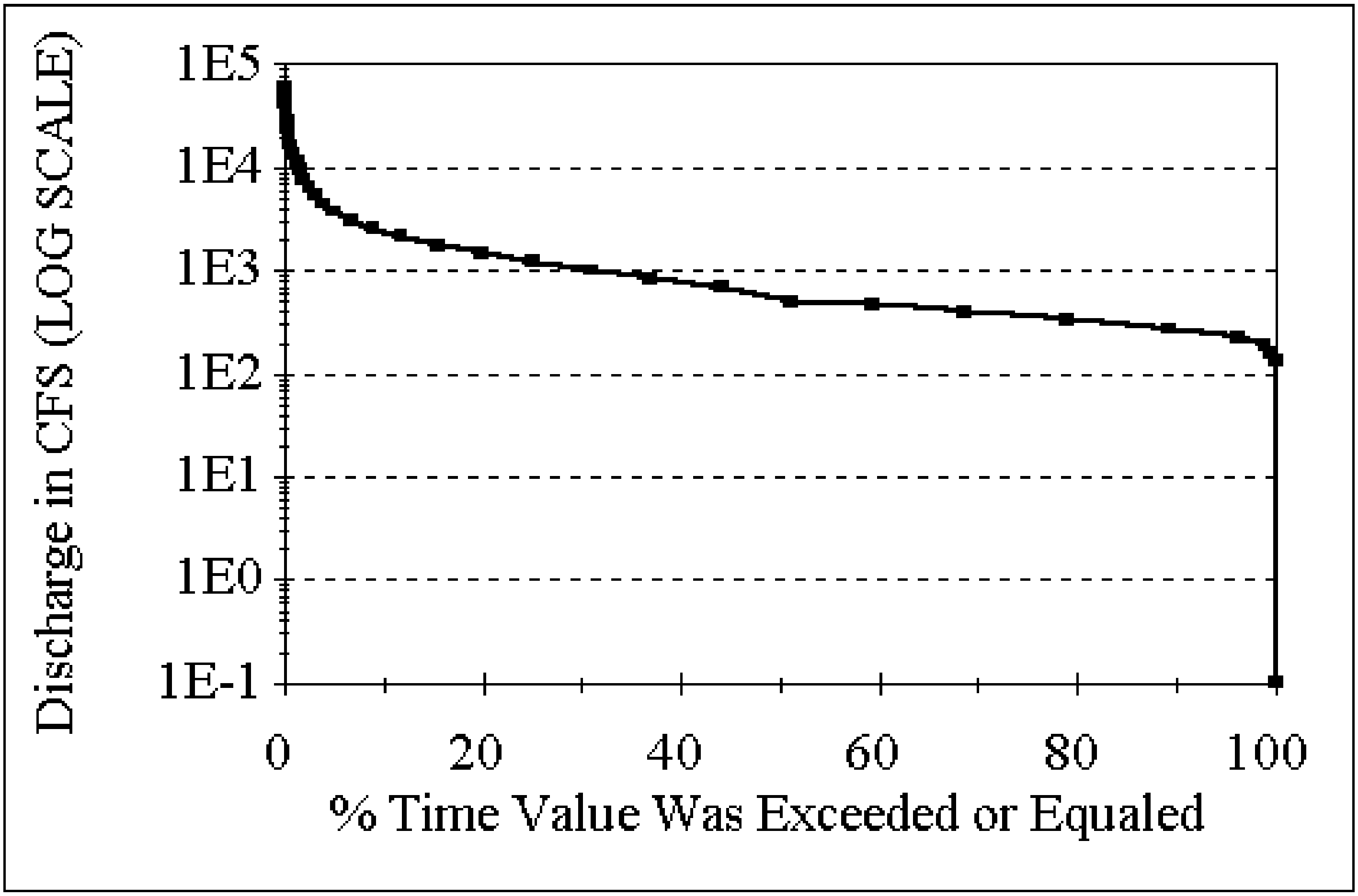


Figure 10. Low-normal duration plot for October - September on the Meramec River near Steelville, Missouri for years 1923-1994.

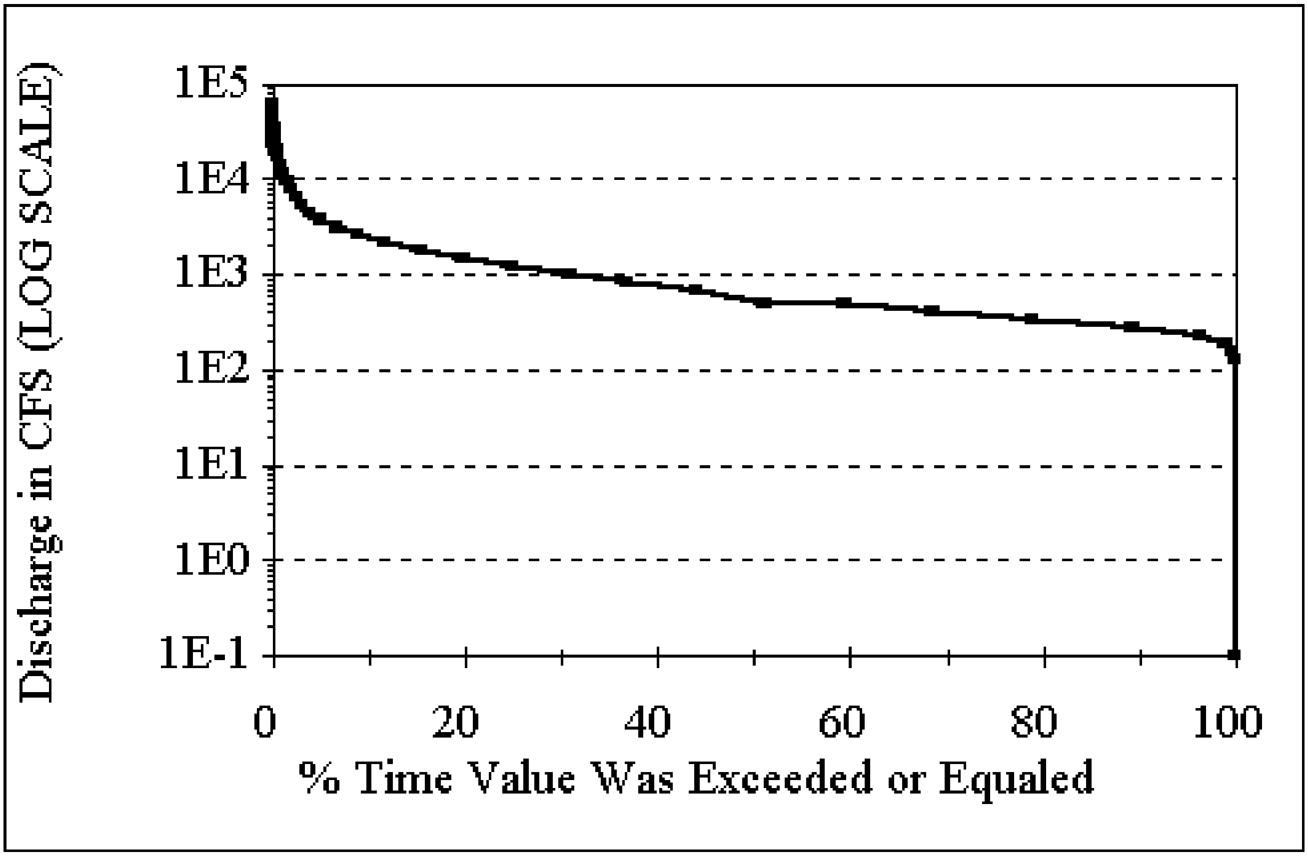


Figure 11. Low-normal duration plot for October-September on the Meramec River near Sullivan, Missouri for years 1922-1995.€€

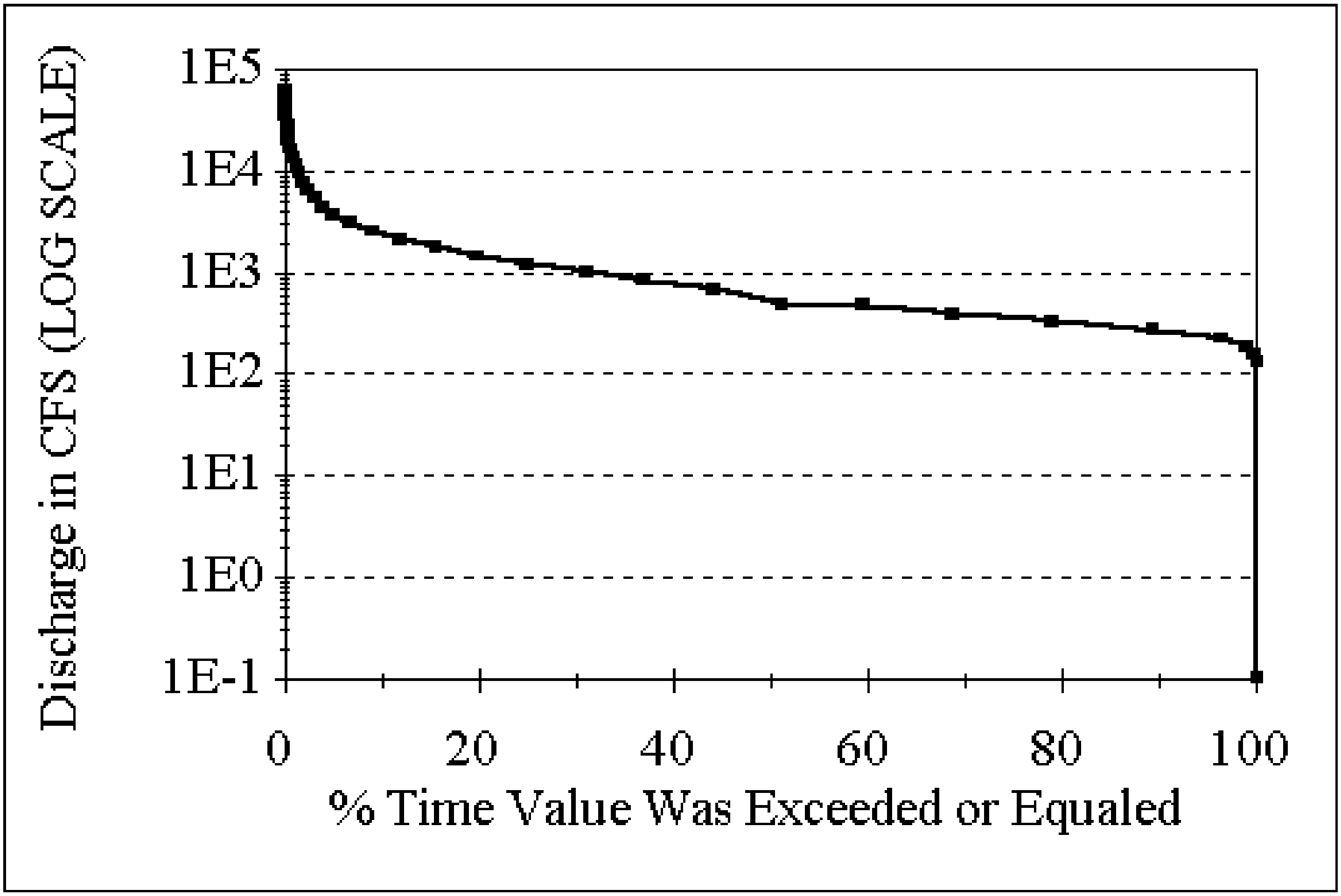


Figure 12. Low-normal duration plot for October - September on the Meramec River near Eureka, Missouri for years 1904-1995.

Table 7. Permanence of stream flow (fishable waters) in third-order and larger streams in the Meramec River basin (Funk 1968). Note: Dry reaches are not reflected in the estimates of total stream length. RM = river mile.

Stream Name	Order[1]	Permanent Stream[2]	Intermittent Pools[2]	Total Length Miles[3]
		Miles	Miles	
Dry Fork Subbasin				
Dry Fork	5	21.5	37.5	75.50
Norman Creek	4			23.85
Little Dry Fork	4	5.0	4.0	13.04
Upper Meramec Subbasin @ RM 216-166				
Benton Creek	4	6.0	2.0	9.50
West Fork Benton Creek	3		2.5	6.32
Crooked Creek	5	18.0	0.5	20.28
Yankee Branch	3	1.0	1.0	6.40
Noname Tributary	3		0.5	3.90
Noname Tributary	3		0.5	2.50
Middle Prong Crooked Creek	3	4.0	2.0	7.35
Dry Valley Creek	4		2.0	14.00
Hutchins Creek	4		1.0	8.55
Huzzah Creek Subbasin				
Huzzah Creek	6	33.0		31.30
Dry Creek	5	4.5	8.5	18.15
Cherry Valley Creek	4		3.0	14.15
Noname	3		1.5	2.50
Noname	4		0.5	2.80
Left tributary to Noname	3		1.0	1.40
Shoal Creek	4	7.5	3.0	11.10
Noname	3		0.5	2.75
Little Shoal Creek	3		1.0	4.20
Middle Fork Shoal Creek	3		1.0	3.85
Pyatt Hollow	3		1.5	4.25
Rock Branch	3		2.5	5.45
Davisville Hollow	3		2.0	4.20
Noname	3		0.5	2.70

James Branch	3	2.0	1.5	4.15
Huzzah Creek Subbasin (con't)				
Indian Creek	3	1.5	1.5	5.50
Crooked Creek	3	3.5		8.90
West Fork Huzzah Creek	4	6.0	1.5	8.62
Barney Creek	3		4.5	7.37
East Fork Huzzah Creek	4	5.0	2.5	9.50
Courtois Creek Subbasin				
Courtois Creek	5	29.5	2.0	34.50
Lost Creek	4	7.0	5.0	14.20
Clear Creek	3		2.0	4.70
Little Lost Creek	4	2.0		6.60
Hazel Creek	4	8.0	2.0	11.50
Little Hazel Creek	3	1.5	0.5	3.75
Johns Creek	3	1.5	1.5	3.55
Cub Creek	4	6.5	0.5	9.75
Trace Creek	3	1.0	1.5	3.80
Unnamed Creek	3		0.5	3.35
Indian Creek	4	1.5		7.60
Middle Meramec Subbasin @ RM 166-110				
Brazil Creek	4	12.0	1.0	15.75
Whites Creek	3	1.5	1.0	4.75
Ashley Branch	3	1.0	1.5	4.80
Little Brazil Creek	3	1.5	1.0	4.00
Blue Springs Creek	3	4.0	1.0	5.85
Hinch Branch	3	1.5	1.0	4.25
Harman Creek	3		2.0	6.75
Lick Creek	4	2.0	2.0	6.15
Whittenburg Creek	4	2.5	5.5	12.85
Yadkin Creek	4		3.0	7.50
Pruett Creek	4	1.0	1.0	3.87
Middle Meramec Subbasin @ RM 166-110 (con't)				

Hamilton Creek	3		2.0	4.50
Indian Creek Subbasin				
Indian Creek	5	19.0	1.5	25.35
Little Indian Creek	4	8.0	1.0	10.90
Noname	3		0.5	2.60
Piney Creek	3		1.0	4.00
Noname	3		0.5	2.15
Levy Hollow	3		1.5	3.70
Dry Branch	4		5.0	7.70
Little Courtois Creek	4	2.0	2.0	5.25
Mary's Creek	3		0.5	3.75
Middle Meramec Subbasin @ RM 110-42				
Brush Creek	3		2.0	7.80
Hoosier Creek	3		1.5	4.60
Brush Creek	3	1.0	1.5	4.25
Calvey Creek	4	2.0	4.0	13.90
Little Calvey Creek	3		1.0	7.15
Little Meramec River	5	3.0		9.0
Lower Meramec River Subbasins				
Lower Meramec River	7	201.0	4.0	218.57
Saline Creek	3		2.0	9.39
Sugar Creek	3	1.0	3.0	6.91
Grand Glaize Creek	4		4.0	11.19
Fishpot Creek	4		0.5	9.16
Carr Creek	3		0.5	3.83
Antire Creek	3	1.5	0.5	7.2

1 Stream order taken from 7.5" topographic maps.
2 Taken from Funk 1968.
3 As determined using hand dividers from 7.5" topographic maps by East Central Region and St. Louis Region Fisheries personnel.

Table 8. Estimated magnitude and frequency of annual low flow within period of record listed except where footnoted (MDNR 1995a, USGS 1995, Skelton 1970).

				Discharge(CFS)			7-Day Low Flow			
Gage No.	Stream	Site	Period of Record	Average	Maximum	Minimum	Q2	Q10	Q20[4]	Slope Index (Q2/Q20)
7-0104	Meramec River	St. James	1953,57 1962-67	-	-	-	22	12	-	-
7-0130	Meramec River	Steelville	1915, 1922-67	587[1]	1,473	177	150	98	86	1.7
7-0140[5]	Huzzah Creek	Dillard	1943-67	-	-	-	18	9.5	-	-
7-0140[5]	Huzzah Creek	Steelville	1942-67	-	-	-	50	28	-	-
7-0142[5]	Courtois Creek	Berryman	1943-67	-	-	-	30	17	-	-
7-0145	Meramec River	Sullivan	1922-67	1,227[2]	3,014	341	300	200	140	2.1
7-0170[5]	Meramec River	Robertsville	1940-50	-	-	-	450	235	-	-
7-0190	Meramec River	Eureka	1922-67	3,187[3]	7,407	751	600	315	225	1.9

Period of Record (USGS 1994)--11922-1993, 21921-1993, 31903-1906, 1921-1993. 4 Period of Record - 1922-94 (USGS 1995) 5 Skelton 1970

Table 9. Base-flow (cfs) recession characteristics. The average rate of decrease of runoff of the stream during periods of no precipitation. Recession data from the period of May through October (Skelton, 1970).

					TIME, IN DAYS				
GAGE NO.	STREAM	SITE	PERIOD OF RECORD	MEASURED FLOW (CFS)	0	10	20	30	40
7-0104	Meramec River	St. James	1953-67	10	35	24	18	14	12
7-0130	Meramec River	Steelville	1923-67	74	150	120	98	82	40
7-0140	Huzzah Creek	Dillard	1943-67	8.4	18	13	9.5	7.2	-
7-0140	Huzzah Creek	Steelville	1942-67	26	50	36	28	22	18
7-0142	Courtois Creek	Berryman	1943-67	16	30	22	17	13	10
7-0145	Meramec River	Sullivan	1922-67	131	300	240	200	170	150
7-0170	Meramec River	Robertsville	1940-50	256	450	310	235	185	150
7-0190	Meramec River	Eureka	1922-67	196	600	420	315	245	200

Table 10. Flood frequency data from stream gaging stations in the Meramec River basin (Hauth 1974).

					MAGNITUDE OF FLOOD IN CFS ($X10^3$), FOR YEARS					
GAGE NO.	STREAM	SITE	BASIN AREA (MI^2)	SLOPE (FT/MI)	2[1]	5[2]	10[3]	25[4]	50[5]	100[6]
7-0130	Meramec River	Steelville	781	6.29	15.4	27.9	36.7	48.1	56.5	64.7
7-0145	Meramec River	Sullivan	1475	4.89	18.6	31.8	40.8	52.0	60.0	68.0
7-0170	Meramec River	Robertsville	2670	3.83	38.7	62.8	78.7	101	-	-
7-0190	Meramec River	Eureka	3790	3.44	37.0	61.2	77.4	97.4	112	125